BMC Oral Health

RESEARCH

Open Access

Eating behaviors, oral health care knowledge, and oral hygiene practices among residents in Fujian province, China: a cross-sectional study

Mei-Ling Zheng[1], Fa Chen[2], Hao Yu[3] and Chang-Yuan Zhang[3*]

Abstract

Background There is little literature that focuses on eating behaviors, oral health care knowledge and oral hygiene habits at the same time. People's oral health is affected by a variety of factors. This study investigated the eating behaviors, oral health care knowledge, and oral hygiene practices among residents of Fujian province, China, with different gender, age, and educational attainment.

Methods A self-administered questionnaire was designed and distributed through the online questionnaire platform, Questionnaire Star. After excluding unqualified responses (due to excessively short completion time, conflicting answers, etc.), an Excel database was constructed. Frequency counts (composition ratio) were used to characterize data distribution, and the chi-square test was used to compare self-reported oral health, eating behaviors, oral health care knowledge, and oral hygiene practices across different age, gender, and educational attainment of respondents. Data were analyzed using IBM SPSS (version 26.0), and differences were considered statistically significant at $P < 0.05$.

Results A total of 10,480 individuals completed the online questionnaire, with 8,254 questionnaires deemed valid, yielding a validity rate of 78.76%. Significant differences were observed in various aspects of eating behaviors among respondents of different age, gender, and educational attainment ($P < 0.001$), except for the consumption of fruit juice and hard foods. There was a significant difference in self-reported oral health status among respondents by age and education ($P \leq 0.001$), while the difference by gender was not significant ($P = 0.303$). The respondents displayed inadequate oral health care knowledge, with significant disparities among respondents of different age, gender, and educational attainment ($P < 0.05$). There were also significant differences in oral hygiene practices among respondents of different age, gender, and educational attainment ($P < 0.05$).

Conclusions Eating behaviors, oral health care knowledge and oral hygiene practices of Fujian residents were related to age, gender and education attainment. Educational attainment was an important factor influencing the eating behaviors, oral health knowledge and oral hygiene practices of the population. Local residents' knowledge of oral health care was generally insufficient.

Keywords Eating behaviors, Oral health care knowledge, Oral hygiene practices, Oral health, Cross-sectional study, Fujian, China

*Correspondence:
Chang-Yuan Zhang
longsource@126.com
Full list of author information is available at the end of the article

Background

Oral health has a profound impact on individual's oral function and social interactions, with repercussions extending to overall health and quality of life [1]. Despite the advances in dental care, inadequate oral health continues to be significant global concern, affecting both individuals and developing nations, with an estimated of 3.9 billion people worldwide suffering from various oral diseases [2, 3]. Recognizing gravity of the situation, the World Health Organization (WHO) has identified oral health as one of the most prevalent and serious public health problems [4].

People's oral health is influenced by many factors, such as educational attainment [5], oral health care knowledge [6], socioeconomic status [7], cultural backgrounds [8], socio-demographic characteristics [9], and oral hygiene behaviors [10]. Eating behaviors are closely related to oral health [11]. Eating disorders affect oral health [12], and eating behaviors are associated with tooth caries occurrence [13]. Charak N et al. found that there was a positive correlation between problematic eating behaviors and early children caries [14]. Oral hygiene knowledge and oral hygiene practices influence oral health in different ways [6, 15]. Oral health care knowledge and good oral hygiene habits are vital to maintaining good health enable individuals to take steps to protect their health [16]. Poor oral hygiene can lead to the development of dental caries and periodontitis, and is also associated with heart disease, cancer, and diabetes [17].

In recent years, China's rapid socioeconomic development and the enhanced living standards of its populace have led to profound shifts in dietary habits. These changes have consequently brought about new dynamics in the realm of oral health [18, 19]. Fujian province, located on the southeastern coast of Chinese mainland, boasts a land area of 124,000 square kilometers and a population of 41.88 million. As of 2022, Fujian province recorded a Gross Domestic Products (GDP) of 5,310.985 billion Chinese Yuan (CNY), with a per capita GDP of 126,829 CNY. Fujian province's economic profile reflects its significant development and progress, ranking fourth among the 31 provinces in mainland China. Such development has likely contributed to shifts in oral health literacy and oral health behaviors, which are often influenced by socio-demographic factors. Currently, there is a scarcity of literature focusing on the eating behaviors, oral health care knowledge and oral hygiene practices of residents in Fujian province, China. Consequently, there is a critical need to assess the current levels of oral health knowledge and practices in order to inform policymakers and guide the development of targeted programs aimed at preventing prevalent oral diseases and enhancing oral health of the population [20]. Therefore, the aim of present study was to investigate the eating behaviors, oral health care knowledge, and oral hygiene practices of residents in Fujian province, China, across different age, gender, and educational attainment.

Methods

Study design

A cross-sectional survey was conducted among residents in Fujian province, China. The study adhered to the Declaration of Helsinki, and the study protocol was reviewed and approved by the Ethics Review Committee of School and Hospital of Stomatology, Fujian Medical University (No. 2023050).

Instrument

The study employed a self-administered questionnaire that drew inspiration from several surveys addressing similar themes [21, 22].

Following the establishment of the survey, a pilot study was conducted to assess its comprehensibility and gauge response rates among potential respondents. The preliminary survey involved 30 individuals and aimed to ensure that the questionnaire was easy to understand. Respondents were able to complete the questionnaire within 3 to 10 min. Three questions were identified in previous validation phase that were overly specialized and challenging for non-dental professionals to comprehend and respond to. Subsequently, these questions were removed following deliberation. The test was then repeated with a sample size of 30. The Cronbach's in the present study was 0.81, showing that it had good internal consistency.

This study aimed to understand the self-reported oral health, eating behaviors, oral health care knowledge, and oral hygiene practices of residents in Fujian province, China, and the relationships among them. Thus, the formal questionnaire (refer to supplementary material) consisted of four sections with 25 questions, all of which were single-choice, as shown in Fig. 1. The first section (Part I) collected demographic information about the participants, including details such as age, gender, educational attainment, and self-reported oral health. The second section (Part II) consisted of 7 questions which focused on respondents' eating behaviors. The third section (Part III) consisted of 4 questions aimed at assessing respondents' oral health care knowledge. The last section (Part IV) consisted of 10 questions related to oral hygiene practices. The questionnaire was revised and validated by a panel of five dental professionals who possessed extensive clinical and teaching experience. The questionnaire was presented in Chinese.

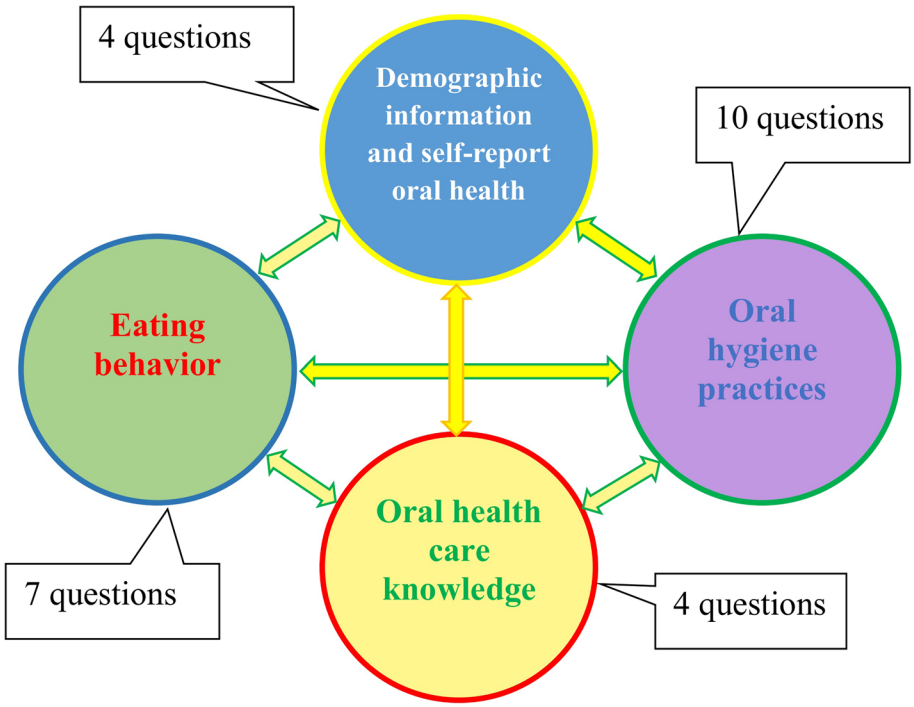

Fig. 1 Structure of self-administered questionnaire

Informed consent

The preamble of the questionnaire included informed consent information, assured participants that the data collected would be used exclusively for scientific research purposes, and emphasized confidentiality. Prior to engaging in the questionnaire, participants were provided with instructions. Importantly, participants were informed of their right to discontinue or withdraw from the survey at any point during its completion, but at the same time they were encouraged to complete the survey.

Data analysis

Data collection and analysis were carried out from May to August 2023. Excel was used to construct the database, frequency counts (constitutive ratios) were used to characterize the distribution of data, and the chi-square test was used to compare differences in self-reported oral health, eating behaviors, oral health care knowledge, and oral hygiene practices among the respondents of different age, gender, and educational attainment. Data were analyzed using IBM SPSS (version 26.0) and differences were considered statistically significant at $P < 0.05$.

Meanwhile, multivariate ordered logistic regression was used to explore the association of demographic factors, eating behaviors, and oral hygiene practices with self-reported oral health (an ordinal dependent variable, which was divided into good, fair, and poor).

Results

A total of 10,480 residents completed the questionnaire. The collected questionnaires underwent a rigorous validity assessment. If the questionnaire was completed too quickly (less than 2 min, which was significantly less than the average response time for pre-test), it may not have been read carefully and was therefore invalid. As well as those containing contradictory responses, such as respondents indicating they never ate hard food but also stating they occasionally ate super hard food, were excluded from the analysis. The presence of contradictory answers indicated that the respondents did not answer carefully and truthfully. Each respondent's answers were double-checked and questionnaires with contradictory answers were excluded. Finally, a total of 8,254 questionnaires were deemed valid, with a validity rate of 78.76%.

Descriptive statistics

Out of the 8,254 valid questionnaires, a total of 3,100 (37.56%) belonged to male respondents, while 5,154 (62.44%) were submitted by female respondents. The majority of respondents were between the ages of 18–45. Additionally, an impressive 6,397 (77.50%) of the respondents reported having attained a university (5959, 72.20%) or postgraduate (438, 5.31%) education (Table 1).

Table 1 Characteristics of the respondents

Characteristics	No	%
Age		
< 18	195	2.36
18–45	5807	70.35
> 45	2252	27.28
Gender		
Male	3,100	37.56
Female	5,154	62.44
Educational attainment		
High school or below	1,857	22.49
College	5,959	72.20
Postgraduate	438	5.31

Self-reported oral health

The self-reported oral health of the respondents was summarized in Table 2. Most of the respondents considered their oral health to be fair (3998, 48.44%) or poor (3210, 38.89%). There were significant differences in self-reported oral health based on age and educational attainment ($P \leq 0.001$). However, there were no significant differences in self-reported oral health based on gender ($P = 0.303$).

Eating behaviors

The eating behaviors of respondents were shown in Table 3. Citrus fruits were commonly consumed by local residents. Majority of the respondents preferred to either never or occasionally consume juice or alcohol. Tea was the most commonly consumed beverage among the respondents. Most respondents reported occasionally or often consuming hard and super-hard foods. 45.52% of the respondents never used their teeth to bite crab shells or open beer caps, but there were a relatively large number of respondents who reported occasionally (45.46%) or often (8.50%) using their teeth for such purposes. Interestingly, a very small percentage (0.52%) admitted to using their teeth to bite crab shells or open beer caps every day.

For different age groups, there were significant differences in all aspects of eating behaviors among respondents ($P < 0.001$). There were significant differences between male and female in many aspects of their eating behaviors, with the exception of drinking fruit juice and eating hard foods. Notably, a higher percentage of male reported eating both hard and super-hard foods every day compared to female ($P < 0.001$). There were also significant differences in various aspects of eating behaviors among people with different educational attainments ($P < 0.001$).

Oral health care knowledge

The oral health care knowledge of the respondents was shown in Table 4. Internet was the primary channel through which respondents gained oral health care knowledge. A whopping 67.83% of respondents completely (1523, 18.45%) or partially (4076, 49.38%) agreed that professional teeth cleaning (PTC) may be harmful to oral health. Pit and fissure sealing (PFS) was poorly known, and only 3.05% of respondents were completely aware of oral health criteria. There were significant differences in oral health care knowledge among respondents of different age, gender, and educational attainment ($P < 0.05$).

Oral hygiene practices

The oral hygiene practices of the respondents were shown in Table 5. Manual toothbrush was the primary choice (82.32%) among the respondents. Most respondents (68.10%) brushing teeth twice a day, and respondents brushed their teeth mainly for 1–3 min, with 47.21% for 1–2 min and 35.45% for 2–3 min. Respondents tended to change their toothbrush irregularly. Toothpicks were the most commonly used oral hygiene care tool among respondents, while there was a notable percentage of

Table 2 Differences in self-reported oral health among respondents of different age, gender, and educational attainment

	Categories	Good *n* (%)	Fair *n* (%)	Poor *n* (%)	χ^2	*P*
Age	< 18	35(17.95)	105(53.85)	55(28.21)	19.62	0.001
	18–45	755(13.00)	2829(48.72)	2223(38.28)		
	> 45	256(11.37)	1064(47.25)	932(41.39)		
Gender	Male	413(13.32)	1476(47.61)	1211(39.06)	2.39	0.303
	Female	633(12.28)	2522(48.93)	1999(38.79)		
Educational attainment	High school or below	280(15.08)	959(51.64)	618(33.28)	36.69	< 0.001
	College	718(12.05)	2837(47.61)	2404(40.34)		
	Postgraduate	48(10.96)	202(46.12)	188(42.92)		
Total		1046(12.67)	3998(48.44)	3210(38.89)		

Table 3 Differences in eating behavior among respondents by gender, age, and educational attainment

		Frequency of eating citrus fruits				Frequency of drinking fruit juice			
		Never	**Occasionally, less than 2 times per week**	**Often, but less than 1 time per day**	**Always, 1 or more times per day**	**Never**	**Occasionally, less than 2 times per week**	**Often, but less than 1 time per day**	**Always, 1 or more times per day**
Gender	Male *n* (%)	33 (1.06)	1353 (43.65)	1383 (44.61)	331 (10.68)	182 (5.87)	2155 (69.52)	659 (21.26)	104 (3.35)
	Female*n* (%)	40 (0.78)	2128 (41.29)	2329 (45.19)	657 (12.75)	322 (6.25)	3506 (68.02)	1158 (22.47)	168 (3.26)
	χ2	11.44				2.42			
	P	0.01				0.49			
Age	< 18 years *n* (%)	4 (2.05)	76 (38.97)	82 (42.05)	33 (16.92)	12 (6.15)	110 (56.41)	57 (29.23)	16 (8.21)
	18–45 years *n* (%)	37 (0.64)	2449 (42.17)	2703 (46.55)	618 (10.64)	266 (4.58)	3792 (65.30)	1536 (26.45)	213 (3.67)
	> 45 years n (%)	32 (1.42)	956 (42.45)	927 (41.16)	337 (14.96)	226 (10.04)	1759 (78.11)	224 (9.95)	43 (1.91)
	χ2	55.12				357.55			
	P	< 0.001				< 0.001			
Educational Attainment	HS or B *n* (%)	33 (1.78)	1021 (54.98)	551 (29.67)	252 (13.57)	167 (8.99)	1378 (74.21)	234 (12.60)	78 (4.20)
	C *n* (%)	39 (0.65)	2335 (39.18)	2914 (48.90)	671 (11.26)	320 (5.37)	4011 (67.31)	1446 (24.27)	182 (3.05)
	P *n* (%)	1 (0.23)	125 (28.54)	247 (56.39)	65 (14.84)	17 (3.88)	272 (62.10)	137 (31.28)	12 (2.74)
	χ2	265.9				158.46			
	P	< 0.001				< 0.001			
Total *n* (%)		73 (0.88)	3481 (42.17)	3712 (44.97)	988 (11.97)	504 (6.11)	5661 (68.58)	1817 (22.01)	272 (3.30)
	Frequency of drinking tea					Frequency of drinking alcohol			
		Never	Occasionally, less than 2 times per week	Often, but less than 1 time per day	Always, 1 or more times per day	Never	Occasionally, less than 2 times per week	Often, but less than 1 time per day	Always, 1 or more times per day
Gender	Male *n* (%)	57 (1.84)	795 (25.65)	686 (22.13)	1562 (50.39)	364 (11.74)	1624 (52.39)	953 (30.74)	159 (5.13)
	Female*n* (%)	353 (6.85)	2409 (46.74)	1091 (21.17)	1301 (25.24)	1280 (24.84)	3339 (64.78)	493 (9.57)	42 (0.81)
	χ2	673.41				859.54			
	P	< 0.001				< 0.001			
Age	< 18 years *n* (%)	23 (11.79)	87 (44.62)	34 (17.44)	51 (26.15)	119 (61.03)	60 (30.77)	15 (7.69)	1 (0.51)
	18–45 years *n* (%)	343 (5.91)	2505 (43.14)	1352 (23.28)	1607 (27.67)	1232 (21.22)	3540 (60.96)	913 (15.72)	122 (2.10)
	> 45 years *n* (%)	44 (1.95)	612 (27.18)	391 (17.36)	1205 (53.51)	293 (13.01)	1363 (60.52)	518 (23.00)	78 (3.46)
	χ2	522.42				328.47			
	P	< 0.001				< 0.001			
Educational Attainment	HS or B *n* (%)	123 (6.62)	731 (39.36)	279 (15.02)	724 (38.99)	481 (25.90)	1088 (58.59)	214 (11.52)	74 (3.98)
	C *n* (%)	279 (4.68)	2336 (39.20)	1374 (23.06)	1970 (33.06)	1107 (18.58)	3608 (60.55)	1123 (18.85)	121 (2.03)
	P *n* (%)	8 (1.83)	137 (31.28)	124 (28.31)	169 (38.58)	56 (12.79)	267 (60.96)	109 (24.89)	6 (1.37)
	χ2	95.4				132.92			
	P	< 0.001				< 0.001			
Total *n* (%)		410 (4.97)	3204 (38.82)	1777 (21.53)	2863 (34.69)	1644 (19.92)	4963 (60.13)	1446 (17.52)	201 (2.44)
	Frequency of eating hard foods					Frequency of eating super-hard foods			
		Never	Occasionally, less than 2 times per week	Often, but less than 1 time per day	Always, 1 or more times per day	Never	Occasionally, less than 2 times per week	Often, but less than 1 time per day	Always, 1 or more times per day
Gender	Male *n* (%)	51 (1.65)	1780 (57.42)	1151 (37.13)	118 (3.81)	178 (5.74)	2398 (77.35)	498 (16.06)	26 (0.84)
	Female *n* (%)	118 (2.29)	2932 (56.89)	1890 (36.67)	214 (4.15)	227 (4.40)	3820 (74.12)	1044 (20.26)	63 (1.22)
	χ2	4.71				30.6			
	P	0.195				< 0.001			

Table 3 (continued)

		Frequency of eating citrus fruits				Frequency of drinking fruit juice			
		Never	**Occasionally, less than 2 times per week**	**Often, but less than 1 time per day**	**Always, 1 or more times per day**	**Never**	**Occasionally, less than 2 times per week**	**Often, but less than 1 time per day**	**Always, 1 or more times per day**
Age	< 18 years *n* (%)	12 (6.15)	119 (61.03)	56 (28.72)	8 (4.10)	24 (12.31)	125 (64.10)	43 (22.05)	3 (1.54)
	18–45 years *n* (%)	128 (2.20)	3359 (57.84)	2110 (36.34)	210 (3.62)	214 (3.69)	4300 (74.05)	1224 (21.08)	69 (1.19)
	> 45 years *n* (%)	29 (1.29)	1234 (54.80)	875 (38.85)	114 (5.06)	167 (7.42)	1793 (79.62)	275 (12.21)	17 (0.75)
	χ2	41.1				151.06			
	P	< 0.001				< 0.001			
Educational Attainment	HS or B *n* (%)	46 (2.48)	1302 (70.11)	442 (23.80)	67 (3.61)	153 (8.24)	1474 (79.38)	213 (11.47)	17 (0.92)
	C *n* (%)	119 (2.00)	3229 (54.19)	2375 (39.86)	236 (3.96)	229 (3.84)	4440 (74.51)	1224 (20.54)	66 (1.11)
	P *n* (%)	4 (0.91)	181 (41.32)	224 (51.14)	29 (6.62)	23 (5.25)	304 (69.41)	105 (23.97)	6 (1.37)
	χ2	220.45				132.61			
	P	< 0.001				< 0.001			
Total *n* (%)		169 (2.05)	4712 (57.09)	3041 (36.84)	332 (4.02)	405 (4.91)	6218 (75.33)	1542 (18.68)	89 (1.08)
	Frequency of using teeth to bite crab shells or open beer caps								
		Never	Occasionally, less than 2 times per week	Often, but less than 1 time per day	Always, 1 or more times per day				
Gender	Male *n* (%)	1186 (38.26)	1645 (53.06)	248 (8.00)	21 (0.68)				
	Female *n* (%)	2571 (49.88)	2107 (40.88)	454 (8.81)	22 (0.43)				
	χ2	124.51							
	P	< 0.001							
Age	< 18 years *n* (%)	110 (56.41)	67 (34.36)	17 (8.72)	1 (0.51)				
	18–45 years *n* (%)	2459 (42.35)	2718 (46.81)	594 (10.23)	36 (0.62)				
	> 45 years *n* (%)	1188 (52.75)	967 (42.94)	91 (4.04)	6 (0.27)				
	χ2	131.53							
	P	< 0.001							
Educational Attainment	HS or B *n* (%)	993 (53.47)	774 (41.68)	81 (4.36)	9 (0.48)				
	C *n* (%)	2621 (43.98)	2748 (46.12)	558 (9.36)	32 (0.54)				
	P *n* (%)	143 (32.65)	230 (52.51)	63 (14.38)	2 (0.46)				
	χ2	116.59							
	P	< 0.001							
Total *n* (%)		3757 (45.52)	3752 (45.46)	702 (8.50)	43 (0.52)				

individuals who had never used dental floss and oral irrigator. A total of 82.64% (73.78% often and 8.86% always) of the respondents experienced gingival bleeding during tooth brushing. A very small percentage of (9.44%) the respondents routinely visited dental facilities for PTC. There were significant differences in the oral hygiene practices of the respondents in terms of age, gender, and educational attainments ($P < 0.05$), with the exception of PTC among individuals of different gender ($P = 0.118$).

Multivariate ordered logistic regression

Multivariate ordered logistic regression demonstrated that age, educational attainment, oral health practice score, frequency of eating hard foods were negative associated with self-reported oral health, while frequency of drinking tea showed a positive association (Table 6).

Discussion

Oral health is very important and there is a relatively large body of literature examining oral health status, oral health care knowledge and oral hygiene practices. However, few articles have examined eating behaviors, oral health knowledge, and oral hygiene practices simultaneously. This study attempted to simultaneously explore the eating behaviors, oral health care knowledge and oral hygiene practices of residents in Fujian province, China, with

Table 4 Differences in oral health care knowledge among respondents by gender, age, and educational attainment

		The most important source of oral health care knowledge			**Do you agree with "professional tooth cleaning would damage the teeth"?**			
		Internet	**Dentist**	**Television, newspapers and others**	**Completely disagree**	**Disagree**	**Agree**	**Completely agree**
Gender	Male *n* (%)	2165 (69.84)	411 (13.26)	524 (16.90)	102 (3.29)	811 (26.16)	1519 (49.00)	668 (21.55)
	Female *n* (%)	3790 (73.54)	706 (13.70)	658 (12.77)	188 (3.65)	1554 (30.15)	2557 (49.61)	855 (16.59)
	χ2	27.07			37.41			
	P	< 0.001			< 0.001			
Age	< 18 years *n* (%)	115 (58.97)	32 (16.41)	48 (24.62)	17 (8.72)	50 (25.64)	98 (50.26)	30 (15.38)
	18–45 years *n* (%)	4550 (78.35)	701 (12.07)	556 (9.57)	221 (3.81)	1730 (29.79)	2843 (48.96)	1013 (17.44)
	> 45 years *n* (%)	1290 (57.28)	384 (17.05)	578 (25.67)	52 (2.31)	585 (25.98)	1135 (50.40)	480 (21.31)
	χ2	443.82			49.52			
	P	< 0.001			< 0.001			
Educational Attainment	HS or B *n* (%)	992 (53.42)	432 (23.26)	433 (23.32)	64 (3.45)	486 (26.17)	916 (49.33)	391 (21.06)
	C *n* (%)	4627 (77.65)	628 (10.54)	704 (11.81)	198 (3.32)	1722 (28.90)	2967 (49.79)	1072 (17.99)
	P *n* (%)	336 (76.71)	57 (13.01)	45 (10.27)	28 (6.39)	157 (35.84)	193 (44.06)	60 (13.70)
	χ2	422.12			38.58			
	P	< 0.001			< 0.001			
Total *n* (%)		5955 (72.15)	1117 (13.53)	1182 (14.32)	290 (3.51)	2365 (28.65)	4076 (49.38)	1523 (18.45)
		Do you know about dental pit and fissure sealing?			Do you know the criteria for oral health?			
		Not at all	Yes	Yes, and myself or a family member or friend has had pit and fissure sealing	Not at all	Partially		Completely
Gender	Male *n* (%)	1866 (60.19)	812 (26.19)	422 (13.61)	1752 (56.51)	1265 (40.81)		83 (2.68)
	Female *n* (%)	2272 (44.08)	1866 (36.20)	1016 (19.71)	2102 (40.78)	2883 (55.94)		169 (3.28)
	χ2	201.36			236.56			
	P	< 0.001			< 0.001			
Age	< 18 years *n* (%)	112 (57.44)	51 (26.15)	32 (16.41)	75 (38.46)	104 (53.33)		16 (8.21)
	18–45 years *n* (%)	2713 (46.72)	1967 (33.87)	1127 (19.41)	2698 (46.46)	2910 (50.11)		199 (3.43)
	> 45 years *n* (%)	1313 (58.30)	660 (29.31)	279 (12.39)	1081 (48.00)	1134 (50.36)		37 (1.64)
	χ2	104.42			43.48			
	P	< 0.001			< 0.001			
Educational Attainment	HS or B *n* (%)	1109 (59.72)	544 (29.29)	204 (10.99)	810 (43.62)	980 (52.77)		67 (3.61)
	C *n* (%)	2887 (48.45)	1982 (33.26)	1090 (18.29)	2824 (47.39)	2966 (49.77)		169 (2.84)
	P *n* (%)	142 (32.42)	152 (34.70)	144 (32.88)	220 (50.23)	202 (46.12)		16 (3.65)
	χ2	179.22			19.76			
	P	< 0.001			0.003			
Total *n* (%)		4138 (50.13)	2678 (32.44)	1438 (17.42)	3854 (46.69)	4148 (50.25)		252 (3.05)

particular attention to potential differences among populations of different age, gender, and educational attainment.

Self-report oral health

Oral diseases remain a significant public health concern, affecting a substantial portion of the population and contributing to the global burden of oral health problems [23]. The results of this study showed that only 12.67% of the respondents considered their oral health to be good, while 87.33% rated their oral health as fair or poor. These findings were consistent with previous study conducted in China [24]. This data suggests that the overall oral health level among residents in Fujian province is still

Table 5 Differences in oral hygiene practices among respondents by gender, age, and educational attainment

		Type of toothbrush used				Number of times of tooth brushing per day			
		Manual toothbrush		**Electric toothbrush**		**≤ 1 time**	**2 times**		**≥ 3 times**
Gender	Male *n* (%)	2642 (85.23)		458 (14.77)		1162 (37.48)	1721 (55.52)		217 (7.00)
	Female *n* (%)	4153 (80.58)		1001 (19.42)		837 (16.24)	3900 (75.67)		417 (8.09)
	χ2	28.73				479.16			
	P	< 0.001				< 0.001			
Age	< 18 years *n* (%)	159 (81.54)		36 (18.46)		66 (33.85)	114 (58.46)		15 (7.69)
	18–45 years *n* (%)	4586 (78.97)		1221 (21.03)		1348 (23.21)	4088 (70.40)		371 (6.39)
	> 45 years *n* (%)	2050 (91.03)		202 (8.97)		585 (25.98)	1419 (63.01)		248 (11.01)
	χ2	162.18				73.65			
	P	< 0.001				< 0.001			
Educational Attainment	HS or B *n* (%)	1698 (91.44)		159 (8.56)		612 (32.96)	1160 (62.47)		85 (4.58)
	C *n* (%)	4789 (80.37)		1170 (19.63)		1309 (21.97)	4149 (69.63)		501 (8.41)
	P *n* (%)	308 (70.32)		130 (29.68)		78 (17.81)	312 (71.23)		48 (10.96)
	χ2	165.07				123.28			
	P	< 0.001				< 0.001			
Total *n* (%)		6795 (82.32)		1459 (17.68)		1999 (24.22)	5621 (68.10)		634 (7.68)
		Time for tooth brush				Frequency of toothbrush replacement			
		Less than 1 min	1–2 min	2–3 min	More than 3 min	1 month	3 months	6 months or more	irregularly
Gender	Male *n* (%)	265 (8.55)	1542 (49.74)	996 (32.13)	297 (9.58)	408 (13.16)	1043 (33.65)	337 (10.87)	1312 (42.32)
	Female *n* (%)	326 (6.33)	2355 (45.69)	1930 (37.45)	543 (10.54)	668 (12.96)	2215 (42.98)	298 (5.78)	1973 (38.28)
	χ2	37.26				115.87			
	P	< 0.001				< 0.001			
Age	< 18 years *n* (%)	16 (8.21)	87 (44.62)	64 (32.82)	28 (14.36)	47 (24.10)	55 (28.21)	8 (4.10)	85 (43.59)
	18–45 years *n* (%)	350 (6.03)	2664 (45.88)	2130 (36.68)	663 (11.42)	718 (12.36)	2431 (41.86)	403 (6.94)	2255 (38.83)
	> 45 years *n* (%)	225 (9.99)	1146 (50.89)	732 (32.50)	149 (6.62)	311 (13.81)	772 (34.28)	224 (9.95)	945 (41.96)
	χ2	93.39				78.56			
	P	< 0.001				< 0.001			

Table 5 (continued)

		Type of toothbrush used				Number of times of tooth brushing per day			
		Manual toothbrush		**Electric toothbrush**		**≤ 1 time**	**2 times**		**≥ 3 times**
Educational Attainment	HS or B *n* (%)	185 (9.96)	923 (49.70)	575 (30.96)	174 (9.37)	337 (18.15)	585 (31.50)	87 (4.68)	848 (45.67)
	C *n* (%)	378 (6.34)	2800 (46.99)	2165 (36.33)	616 (10.34)	705 (11.83)	2468 (41.42)	499 (8.37)	2287 (38.38)
	P *n* (%)	28 (6.39)	174 (39.73)	186 (42.47)	50 (11.42)	34 (7.76)	205 (46.80)	49 (11.19)	150 (34.25)
	χ2	53.91				149.61			
	P	< 0.001				< 0.001			
Total *n* (%)		591 (7.16)	3897 (47.21)	2926 (35.45)	840 (10.18)	1076 (13.04)	3258 (39.47)	635 (7.69)	3285 (39.80)
		Whether to use toothpicks				Whether to use dental floss			
		Never		Often, but less than 1 time per day	Always,1 or more times per day	Never	Often, but less than 1 time per day		Always,1 or more times per day
Gender	Male *n* (%)	560 (18.06)		1797 (57.97)	743 (23.97)	1293 (41.71)	1325 (42.74)		482 (15.55)
	Female *n* (%)	1224 (23.75)		3299 (64.01)	631 (12.24)	1810 (35.12)	2248 (43.62)		1096 (21.27)
	χ2	200.23				55.8			
	P	< 0.001				< 0.001			
Age	< 18 years *n* (%)	75 (38.46)		108 (55.38)	12 (6.15)	97 (49.74)	74 (37.95)		24 (12.31)
	18–45 years *n* (%)	1467 (25.26)		3617 (62.29)	723 (12.45)	1977 (34.05)	2630 (45.29)		1200 (20.66)
	> 45 years *n* (%)	242 (10.75)		1371 (60.88)	639 (28.37)	1029 (45.69)	869 (38.59)		354 (15.72)
	χ2	446.67				110.16			
	P	< 0.001				< 0.001			
Educational Attainment	HS or B *n* (%)	340 (18.31)		1163 (62.63)	354 (19.06)	910 (49.00)	717 (38.61)		230 (12.39)
	C *n* (%)	1311 (22.00)		3675 (61.67)	973 (16.33)	2086 (35.01)	2668 (44.77)		1205 (20.22)
	P *n* (%)	133 (30.37)		258 (58.90)	47 (10.73)	107 (24.43)	188 (42.92)		143 (32.65)
	χ2	42.21				197.31			
	P	< 0.001				< 0.001			

Table 5 (continued)

		Type of toothbrush used			Number of times of tooth brushing per day		
		Manual toothbrush	**Electric toothbrush**		**≤ 1 time**	**2 times**	**≥ 3 times**
Total *n* (%)		1784 (21.61)	5096 (61.74)	1374 (16.65)	3103 (37.59)	3573 (43.29)	1578 (19.12)
		Whether to use oral irrigator			Whether to use mouthwash		
		Never	Often, but less than 1 time per day	Always,1 or more times per day	Never	Often, but less than 1 time per day	Always,1 or more times per day
Gender	Male *n* (%)	2679 (86.42)	313 (10.10)	108 (3.48)	1892 (61.03)	849 (27.39)	359 (11.58)
	Female *n* (%)	4303 (83.49)	626 (12.15)	225 (4.37)	2999 (58.19)	1720 (33.37)	435 (8.44)
	χ2	12.84			44.77		
	P	0.002			< 0.001		
Age	< 18 years *n* (%)	164 (84.10)	18 (9.23)	13 (6.67)	103 (52.82)	58 (29.74)	34 (17.44)
	18–45 years *n* (%)	4884 (84.11)	695 (11.97)	228 (3.93)	3554 (61.20)	1859 (32.01)	394 (6.78)
	> 45 years *n* (%)	1934 (85.88)	226 (10.04)	92 (4.09)	1234 (54.80)	652 (28.95)	366 (16.25)
	χ2	10.28			181.52		
	P	0.036			< 0.001		
Educational Attainment	HS or B *n* (%)	1682 (90.58)	129 (6.95)	46 (2.48)	1116 (60.10)	484 (26.06)	257 (13.84)
	C *n* (%)	4983 (83.62)	730 (12.25)	246 (4.13)	3533 (59.29)	1926 (32.32)	500 (8.39)
	P *n* (%)	317 (72.37)	80 (18.26)	41 (9.36)	242 (55.25)	159 (36.30)	37 (8.45)
	χ2	112.65			67.56		
	P	< 0.001			< 0.001		
Total *n* (%)		6982 (84.59)	939 (11.38)	333 (4.03)	4891 (59.26)	2569 (31.12)	794 (9.62)
		Have you had your teeth cleaned at a dental facility?			Do your gums bleed when you brush your teeth?		
		Never	Often, but less than 1 time per year	Always, 1 or more times per year	Never	Often	Always
Gender	Male *n* (%)	1503 (48.48)	1330 (42.90)	267 (8.61)	488 (15.74)	2301 (74.23)	311 (10.03)
	Female *n* (%)	2494 (48.39)	2148 (41.68)	512 (9.93)	945 (18.34)	3789 (73.52)	420 (8.15)
	χ2	4.27			15.38		
	P	0.118			< 0.001		

Table 5 (continued)

		Type of toothbrush used			Number of times of tooth brushing per day		
		Manual toothbrush	**Electric toothbrush**		**≤ 1 time**	**2 times**	**≥ 3 times**
Age	< 18 years *n* (%)	120 (61.54)	54 (27.69)	21 (10.77)	77 (39.49)	105 (53.85)	13 (6.67)
	18–45 years *n* (%)	2802 (48.25)	2418 (41.64)	587 (10.11)	1053 (18.13)	4197 (72.27)	557 (9.59)
	> 45 years *n* (%)	1075 (47.74)	1006 (44.67)	171 (7.59)	303 (13.45)	1788 (79.40)	161 (7.15)
	χ2	31.86			110.7		
	P	< 0.001			< 0.001		
Educational Attainment	HS or B *n* (%)	1091 (58.75)	629 (33.87)	137 (7.38)	357 (19.22)	1376 (74.10)	124 (6.68)
	C *n* (%)	2790 (46.82)	2601 (43.65)	568 (9.53)	991 (16.63)	4408 (73.97)	560 (9.40)
	P *n* (%)	116 (26.48)	248 (56.62)	74 (16.89)	85 (19.41)	306 (69.86)	47 (10.73)
	χ2	176.96			21.23		
	P	< 0.001			< 0.001		
Total *n* (%)		3997 (48.43)	3478 (42.14)	779 (9.44)	1433 (17.36)	6090 (73.78)	731 (8.86)

Table 6 Multivariate ordered logistic regression of the association of demographic factors, eating behaviors, and oral hygiene practices with self-reported oral health

Variables	OR	SE	Wald χ^2	*P*	95% CI of OR
Age (years)					
< 18	ref				
18–45	1.21	0.18	1.64	0.200	0.91–1.61
> 45	1.54	0.23	8.01	0.005	1.14–2.07
Gender					
Female	ref				
Male	0.87	0.04	7.62	0.006	0.79–0.96
Educational attainment					
High school or below	ref				
College	1.37	0.07	33.87	< 0.001	1.23–1.53
Postgraduate	1.73	0.18	26.63	< 0.001	1.41–2.13
Oral health practice score	0.91	0.01	132.02	< 0.001	0.90–0.93
Frequency of eating citrus fruits	0.99	0.03	0.05	0.821	0.93–1.06
Frequency of drinking fruit juice	0.98	0.04	0.28	0.599	0.90–1.06
Frequency of drinking tea	0.95	0.02	4.28	0.038	0.91–1.00
Frequency of alcohol use	0.96	0.03	1.56	0.210	0.90–1.02
Frequency of eating hard foods	1.10	0.04	5.76	0.016	1.02–1.19
Frequency of eating super-hard foods	0.96	0.05	0.62	0.428	0.87–1.06
Frequency of using teeth to bite crab shells or open beer caps	1.03	0.04	0.64	0.421	0.96–1.10

Abbreviations: *OR* Odds ratio, *SE* Standard error, *95% CI* 95% Confidence interval

unsatisfactory, highlighting a great demand for improved oral healthcare services in Fujian province, China.

Su et al. examined the differences in oral health and oral health behaviors among 4741 men and women in the United States and found gender differences ($P < 0.05$), with men reporting poorer oral health, poorer oral hygiene practices, and fewer dental visits [25]. However, in present study, there was no significant difference ($P = 0.303$) in self-reported oral health of the respondents across different gender. This may be due to the fact that self-reported oral health was more subjective, and the United States and China have different cultural and societal norms regarding oral health and healthcare-seeking behaviors. Furthermore, self-reported oral health was used solely as a reference assessment indicator in present study, not as a clinical measure, and this study used it primarily to understand residents' self-rated oral health.

In this study, there was a significant difference in self-reported oral health among respondents with different educational attainments. Interestingly, the lower education level was associated with better self-reported oral health. This may be due to the fact that individuals with lower levels of education may have less knowledge about oral health care. This could lead to a potential lack of awareness regarding oral health problems, resulting in better self-reported oral health. This is corroborated by the fact that the less educated the respondents were, the less they knew about PTC and PFS of the oral health care knowledge (Table 4). This finding was consistent with the conclusion that less educated adults were more likely to lack preventive dental care, as reported by Gordon NP et al. [26]. Therefore, it is important to focus on oral health education for people with low levels of education.

Eating behaviors

A very small percentage (73, 0.88%) of the respondents indicated that they never eat citrus fruits, while majority of the respondents reported eating citrus fruits occasionally (3481, 42.17%) or often (3712, 44.97%) or daily (988, 11.97%). The abundance of locally grown fruits likely contributes to the widespread consumption of citrus fruits in the region. This dietary habit may be deeply rooted in local culture and traditions, making it a common and habitual practice among residents of Fujian province. The results showed that there were significantly fewer respondents who consumed fruit juice than those who consumed citrus fruits. This indicated that the Fujian residents prefer fresh fruits. However, studies have shown that frequent consumption of citrus fruits was associated with non-carious cervical lesions, such as erosion [27]. Frequent consumption of citrus fruits may lead to an increased incidence of dental erosion [28]. Fruit juice

have also been shown to have an erosive effect on teeth for a long time [29]. Therefore, local residents in Fujian province should be advised to reduce the amount and frequency of citrus fruit intake for the sake of oral health.

Tea is a specialty of Fujian province, and the local residents accustomed to drinking tea. The results showed that a very small percentage (only 4.97%) of the respondents never drank tea. The percentage of tea drinkers increased with age ($P<0.001$), the percentage of males who drank tea was significantly higher than that of females ($P<0.001$), and the higher the educational attainment, the more they drank tea ($P<0.001$). Tea is effective in reducing acid production in plaque and Streptococcus Mutans, reducing the incidence of caries [30]. Nanri H et al. found that green tea consumption was positively associated with oral health-related quality of life, regardless of gender, after studying the oral health of 7,514 (3563 males, 3951 females) Japanese who consumed green tea and coffee [31]. The residents should therefore be further encouraged to consume tea for oral health.

Most of the young respondents never drank alcohol, but there was still one young respondent who drank every day. Although only 2.44% of the respondents drank alcohol every day, most of the respondents still drank alcohol occasionally (4963, 60.13%) or often (1446, 17.52%), while the proportion of males who drank alcohol was much higher than that of females ($P<0.001$), which indicated that alcohol was a favorite beverage of the residents in Fujian province. Alcohol consumption is strongly associated with oral health [32]. Alcohol consumption may lead to changes in the micro environment of the oral cavity, resulting in an imbalance of oral flora, which can lead to periodontitis and gum disease [33, 34]. Therefore, for the sake of oral health, Fujian residents should control their alcohol intake. An interesting phenomenon is that there was a significant difference in the amount of alcohol consumed by respondents with different educational attainment ($P<0.001$). Those with the highest levels of education had the lowest proportion of never drinkers and the lowest proportion of daily drinkers. This may be due to the fact that people with high education have higher incomes [35]. Higher incomes provide the necessary financial prerequisites for drinking, while the highly educated are more aware of the bad effects of alcohol on the body. That was why highly educated people reduce the frequency of alcohol consumption.

Although teeth are the hardest tissues in the body, eating hard foods could cause tooth abrasion [36]. Yu et al. studied teeth wear in 1806 residents of Shanghai, China, and found that regular consumption of hard foods was positively associated with tooth wear regardless of age [37]. This study confirmed that Chinese people prefer hard foods again, most of them eat hard or super-hard foods often, very few of them never eat hard (2.05%) or super-hard foods (4.91%), 4.02% of the respondents ate hard foods every day, and 1.08% ate super-hard foods every day. And even 0.52% used their teeth to bite the shell of a crab or the beer caps every day. Tooth enamel is a brittle material that can easily chip under high loads, and the chipping is caused when large, hard objects forcefully touch the biting edges of the teeth [38]. Local residents should therefore be advised not to use their teeth to bite too hard foods, such as prohibiting the use of teeth to open beer caps or bite crab shells.

Oral health care knowledge

With the rapid development and popularization of Internet technology, the Internet has become the main channel for people to acquire knowledge. The present study revealed that irrespective of age, gender, educational attainment, the oral health care knowledge of the respondents was mainly obtained from the Internet. Surprisingly, the role of dentists in oral health education is minimal. Oral health care knowledge is known to be a prerequisite for health-related activities [39]. Lack of oral health care knowledge has emerged as a possible underlying mechanism for poor oral health [40]. Increased knowledge of oral health care is associated with improved oral health-related quality of life [6]. In the future, Chinese dentists should strengthen the application of Internet to publicize proper oral health care knowledge in order to promote the improvement of oral health care. However, at present, the ratio of dentists to the population in China is low, and dentists have to undertake heavy clinical treatment tasks and are unable to take up the full role of oral health education. Sriarj W et al. traced a comparative study of the effectiveness of dentists and professionally trained teachers in educating students in oral health education and found that the students who received oral health education by either a dentist or trained teacher demonstrated improved knowledge and attitudes toward oral health [41]. Therefore, oral health education for teachers can be strengthened in order to enhance students' oral health knowledge through trained teachers.

According to the latest oral health survey in China, gingival bleeding and calculus affected more than 60% of the adolescent population [42]. Calculus is an important cause of periodontal disease and other oral diseases, only by brushing and other self oral health care measures can not completely clear the calculus, so regular PTC in dental clinic is necessary and beneficial to oral health. However, the results showed that as many as 18.45% of the respondents completely believed that PTC was harmful to oral health. Wang Q et al. surveyed 456 Chinese people and found that 21.69% of non-medical personnel

believed that PTC was harmful to teeth, so PTC is not well understood by Chinese people [43]. Yang R et al. [44] reported that only 11.8% of the students in Chinese mainland had PTC in dental clinic, which was consistent with the findings of this study where only 9.44% of the respondents visited dental clinic once a year for PTC. Therefore, the dissemination of knowledge about PTC should be strengthened so that residents can fully realize the importance and necessity of PTC. This study also found that higher levels of education were associated with higher rates of PTC ($P<0.001$), again demonstrating a positive correlation between educational attainment and oral health.

A large number of studies have shown that PFS can effectively prevent dental caries [45, 46]. This study found that a whopping 50.13% of respondents were unaware of PFS and only 3.05% of the respondents were fully aware of the oral health criteria.

All these findings indicate that the respondents' knowledge of oral health care was poor and oral health promotion and education must be strengthened in the future [47, 48].

Oral hygiene practices

Electric toothbrush is more effective than manual toothbrush in removing plaque [49]. But only 17.68% of respondents use electric toothbrush in present study. This could be due to the higher price of electric toothbrush as well as the lack of knowledge among the masses about electric toothbrush.

Toothbrushes are usually stored in bathrooms with high levels of contamination because of the high level of environmental contamination in bathrooms, mainly caused by aerosol-dispersed enteric bacteria. In addition, contaminated toothbrushes are likely to play an important role in many oral and systemic diseases, leading to sepsis as well as gastrointestinal, cardiovascular, respiratory and renal system diseases [50]. Therefore, the toothbrush should be replaced in time. 52.51% of the respondents replaced their toothbrushes within 3 months or less, which shows that the respondents were fully aware of the importance of replacement of toothbrush timely. Women replace their toothbrushes in a shorter period of time than men, which was consistent with previous studies that have concluded that men have poorer oral hygiene practices [25]. Increasing brushing time to a consensus minimum of 2 min improve plaque removal, resulting in significant clinical benefits for oral health [51]. 75.78% of present respondents brush their teeth twice or three times a day, and 54.37% of the brushing time was less than 2 min. This suggested that most respondents brush their teeth enough times, but not long enough each time. After studying the brushing habits of 4,500 Chinese adults, Liu et al. found that the frequency of brushing was inversely related to education and income [52]. The present study also found that frequency and lasting time of tooth brushing increased with the level of education. Thus, oral hygiene practices are closely related to educational attainment.

Toothpicks are widely used in China and are found on restaurant tables everywhere. However, studies suggest that individuals who frequently use toothpicks may have a higher likelihood of developing periodontal disease compared to those who do not [53]. 61.74% of present respondents used toothpicks often and 16.65% use toothpicks every day. Meanwhile, younger, female, and highly educated respondents used toothpicks at a lower rate than older, male, and less educated respondents ($P<0.001$). Dental floss is recommended as opposed to toothpicks because it effectively cleans the adjacent surfaces of the teeth without damaging gums and other periodontal tissues [54]. But 37.59% of present respondents never use dental floss and only 19.12% use dental floss daily. Flossing should be strongly promoted and used among the local population and they should be advised to stop using toothpicks.

Designed to help clean mouth, oral irrigator has been proven to be a safe and effective tool for improving and maintaining oral health [55]. In present study, as many as 84.59% of the respondents had never used oral irrigator and only 4.03% of the respondents used oral irrigator daily, which indicates a serious lack of awareness of oral irrigator among the respondents. Higher education level was associated with higher awareness and utilization of oral irrigator, which was consistent with the finding that less educated adults are more likely to lack preventive dental care [26].

Mouthwash is a liquid aqueous solution that is primarily used to prevent, alleviate and treat oral diseases and maintain oral health [56]. Mouthwash can be used as an adjunct to mechanical tooth cleaning procedures, as they remove almost all residual plaque and are easy to use. In this study, 59.26% of the respondents never used mouthwash and 9.62% of the respondents reported using mouthwash every day, indicating that mouthwash is not widely used among Fujian residents.

Yang R et al. reported that 46.9% of Chinese students suffered from gingival bleeding when brushing their teeth [44], while as many as 82.64% of the respondents in this study reported occasional or frequent suffered from gingival bleeding when brushing their teeth. Gingival bleeding is one of the earliest signs of gingival inflammation. This indicates that the oral health of Fujian residents is low and needs to be further strengthened.

In order to control for potential confounders and to gain a comprehensive and systematic understanding of

the potential relationship between dietary habits and oral health of the local population, multivariate ordered logistic regression analyses were conducted. The results showed that age, educational attainment, oral hygiene practice score, and frequency of eating hard foods were negatively associated with self-reported oral health, while the frequency of tea consumption was positively associated. Therefore, as mentioned earlier, the dietary habits of the population are closely related to oral health and need to be emphasized.

Limitation

Although this study obtained a larger sample, the online survey and the inability to obtain data from some of the non-applicable online personnel was a shortcoming of this study. In addition, this large-sample cross-sectional study only evaluate differences in oral health status and oral hygiene practices across demographic characteristics, but failed to control for the potential confounders.

Third, the number of respondents in this study was large and complex, involving a variety of gender, age, and educational factors, and including a range of self-reported oral health status, eating behaviors, oral health knowledge, and oral hygiene practices. Although this study have analyzed and assessed the situation, a more in-depth multilevel analysis is far from adequate.

Conclusion

Within the limitation of present study, the observations revealed that eating behaviors, oral health care knowledge and oral hygiene practices of Fujian residents were related to age, gender and education attainment. Educational attainment was an important factor influencing the eating behaviors, oral health knowledge and oral hygiene practices of the population. Local residents' knowledge of oral health care is generally insufficient.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-025-05747-3.

Supplementary Material 1

Acknowledgements
Thanks to the 10,480 people who participated in the research for this project.

Authors' contributions
Conceptualization, H.Y., and C.Y.Z.; methodology, M.L.Z., and C.Y.Z.; validation, M.L.Z., and C.Y.Z.; investigation, M.L.Z., and C.Y.Z.; data collation, F,C.; writing-original draft preparation, M.L.Z.; writing-review and editing, H.Y., and C.Y.Z. All authors have read and agreed to the published version of the manuscript.

Funding
None.

Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study adhered to the Declaration of Helsinki, and the study protocol was reviewed and approved by the Ethics Review Committee of School and Hospital of Stomatology, Fujian Medical University (No. 2023052).
Informed consent was obtained from all subjects and/or their legal guardians.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]School and Hospital of Stomatology, Fujian Medical University, Fuzhou, People's Republic of China. [2]Department of Epidemiology and Health Statistics, School of Public Health, Fujian Medical University, Fuzhou, People's Republic of China. [3]Department of Prosthodontics, School and Hospital of Stomatology, Fujian Medical University, No. 246 Yang Qiao Road, Fuzhou 350002, People's Republic of China.

Received: 22 October 2023 Accepted: 3 March 2025
Published online: 27 March 2025

References

1. Vergnes JN, Mazevet M. Oral diseases: A global public health challenge. Lancet. 2020;395(10219):186.
2. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century–the approach of the WHO Global Oral Health Programme. Community Dent Oral Epidemiol. 2003;31(Suppl 1):3–23.
3. Richards D. Oral diseases affect some 3.9 billion people. Evid Based Dent. 2013;14(2):35.
4. Moradi G, Bolbanabad AM, Moinafshar A, Adabi H, Sharafi M, Zareie B. Evaluation of oral health status based on the decayed, missing and filled teeth (DMFT) Index. Iran J Public Health. 2019;48(11):2050–7.
5. Huff M, Kinion E, Kendra MA, Klecan T. Self-esteem: a hidden concern in oral health. J Community Health Nurs. 2006;23(4):245–55.
6. Zheng S, Zhao L, Ju N, Hua T, Zhang S, Liao S. Relationship between oral health-related knowledge, attitudes, practice, self-rated oral health and oral health-related quality of life among Chinese college students: A structural equation modeling approach. BMC Oral Health. 2021;21(1):99.
7. Locker D. Self-esteem and socioeconomic disparities in self-perceived oral health. J Public Health Dent. 2009;69(1):1–8.
8. Kiyak HA. Age and culture: Influences on oral health behaviours. Int Dent J. 1993;43(1):9–16.
9. Moghaddam LF, Vettore MV, Bayani A, et al. The Association of Oral Health Status, demographic characteristics and socioeconomic determinants with Oral health-related quality of life among children: a systematic review and Meta-analysis. BMC Pediatr. 2020;20(1):489.
10. Patel J, Kulkarni S, Doshi D, Reddy BS, Reddy MP, Buunk-Werkhoven YAB. Determinants of oral hygiene behaviour among patients with moderate and severe chronic periodontitis based on the theory of planned behaviour. Int Dent J. 2019;69(1):50–7.
11. Mei D, Deng Y, Li Q, et al. Current status and influencing factors of eating behavior in residents at the age of 18–60: a cross-sectional study in China. Nutrients. 2022;14(13):2585.
12. Silk H, Kwok A. Addressing adolescent oral health: A review. Pediatr Rev. 2017;38(2):61–8.
13. Fildes A, Mallan KM, Cooke L, et al. The relationship between appetite and food preferences in British and Australian children. Int J Behav Nutr Phys Act. 2015;12:116.

14. Charak N, Pathak A, Sidhu HS. To study problematic eating behavior and its association with early childhood caries among 36–71-month-old children using children eating behavior questionnaire. J Indian Soc Pedod Prev Dent. 2021;39(4):379–83.
15. Gomes AC, Rebelo MAB, de Queiroz AC, et al. Socioeconomic status, social support, oral health beliefs, psychosocial factors, health behaviours and health-related quality of life in adolescents. Qual Life Res. 2020;29(1):141–51.
16. Alshahrani S, Alshuaibi A, Alkhaldi M, Koppolu P. Perception and knowledge of patients from different regions in the kingdom of Saudi Arabia towards oral hygiene and oral hygiene aids. Healthcare. 2021;9(5):592.
17. Cianetti S, Valenti C, Orso M, et al. Systematic review of the literature on dental caries and periodontal disease in socio-economically disadvantaged individuals. Int J Environ Res Public Health. 2021;18(23):12360.
18. Lu HX, Tao DY, Lo ECM, et al. The 4th national oral health survey in the Mainland of China: background and methodology. Chin J Dent Res. 2018;21(3):161–5.
19. Gao YB, Hu T, Zhou XD, et al. How root caries differs between middleaged people and the elderly: findings from the 4th national oral health survey of China. Chin J Dent Res. 2018;21(3):221–9.
20. Rajeh MT. Gender differences in oral health care knowledge and practices among adults in Jeddah. Saudi Arabia Clin Cosmet Investig Dent. 2022;14:235–44.
21. Farsi NJ, Merdad Y, Mirdad M, et al. Oral health care knowledge, attitudes, and behaviors among University students in Jeddah. Saudi Arabia Clin Cosmet Investig Dent. 2020;12:515–23.
22. Verma L, Passi S, Sharma U, Gupta J. Oral health care knowledge, attitude, and practices among postgraduate students of Panjab University, Chandigarh: a cross-sectional Study. Int J Clin Pediatr Dent. 2020;13(2):113–8.
23. World Health Organization: Health topics: Oral Health. [May; 2023]. 2023. https://www.who.int/health-topics/oral-health.
24. Zhao C, Zhou H, Ge S, Zhan Z, Zhang S, Liao S. Associations of attitudes and practice toward oral health, socioeconomic status, self-rated oral health, subjective oral symptoms, and oral health-related quality of life among residents in eastern China: a structural equation modeling approach. Patient Prefer Adherence. 2023;17:1689–703.
25. Su S, Lipsky MS, Licari FW, Hung M. Comparing oral health behaviours of men and women in the United States. J Dent. 2022;122:104157.
26. Gordon NP, Mosen DM, Banegas MP. Oral Health Care: A Missing Pillar of Total Health Care? Perm J. 2021;25:21.080.
27. Kolak V, Pešić D, Melih I, Lalović M, Nikitović A, Jakovljević A. Epidemiological investigation of non-carious cervical lesions and possible etiological factors. J Clin Exp Dent. 2018;10(7):e648–56.
28. Salas MM, Nascimento GG, Vargas-Ferreira F, Tarquinio SB, Huysmans MC, Demarco FF. Diet influenced tooth erosion prevalence in children and adolescents: Results of a meta-analysis and meta-regression. J Dent. 2015;43(8):865–75.
29. Darby ET. Dental erosion and the gouty diathesis: Are they usually associated? Dent Cosmos. 1892;34:629–40.
30. Çakır A, Şahin TN. Evaluation of the impact of fluoride in drinking water and tea on the enamel of deciduous and permanent teeth. BMC Oral Health. 2023;23(1):565.
31. Nanri H, Yamada Y, Itoi A, et al. Consumption of green tea but not coffee is associated with the oral health-related quality of life among an older Japanese population: Kyoto-Kameoka cross-sectional study. Eur J Clin Nutr. 2019;73(4):577–84.
32. An R, Li S, Li Q, et al. Oral health behaviors and oral health-related quality of life among dental patients in China: a cross-sectional study. Patient Prefer Adherence. 2022;16:3045–58.
33. Liao Y, Tong XT, Jia YJ, et al. The effects of alcohol drinking on oral microbiota in the Chinese population. Int J Environ Res Public Health. 2022;19(9):5729.
34. Zupo R, Castellana F, De Nucci S, et al. Beverages consumption and oral health in the aging population: a systematic review. Front Nutr. 2021;8:762383.
35. Yang D, Zheng G, Wang H, Li M. Education, income, and happiness: evidence from China. Front Public Health. 2022;10:855327.
36. Grippo JO, Simring M, Coleman TA. Abfraction, abrasion, biocorrosion, and the enigma of noncarious cervical lesions: a 20-year perspective. J Esthet Restor Dent. 2012;24(1):10–23.
37. Yu T, Tao DY, Lu HX, et al. Prevalence and associated factors of tooth wear in Shanghai. Chin J Dent Res. 2021;24(2):95–103.
38. Chai H, Lawn BR. A universal relation for edge chipping from sharp contacts in brittle materials and its use as a simple means of toughness evaluation. Acta Mater. 2008;55(7):2555–61.
39. Harikiran AG, Pallavi SK, Hariprakash S, Ashutosh, Nagesh KS. Oral health-related KAP among 11-to 12-year-old school children in a government-aided missionary school of Bangalore city. Indian J Dent Res. 2008;19(3):236–42.
40. Lee JY. Lower oral health literacy may lead to poorer oral health outcomes. J Evid Based Dent Pract. 2018;18(3):255–7.
41. Sriarj W, Potisomporn P, Sukarawan W. Comparative Study of Oral Health Education Given by a Dentist and Schoolteachers in Thai Grade 3 Students. J Int Soc Prev Community Dent. 2021;11(2):198–206.
42. Zhan J, Zhang Y, Wang X, et al. Related factors of periodontal health among Chinese middle school students, findings from a national cross sectional survey. BMC Oral Health. 2021;21(1):517.
43. Wang Q, Chen H, Jiang L. Assessment of the professional dental cleaning knowledge, behavior and medical compliance among dentists, medical doctors and non-medical staffs: a cross sectional study in Chongqing, China. BMC Oral Health. 2022;22(1):188.
44. Yang R, Tang T, Wu S, Wu L, Lei L, Li H. Self-reported oral health habits, knowledge and conditions of schoolchildren and adolescents in mainland China. J Clin Pediatr Dent. 2023;47(3):96–102.
45. Schwendicke F, Jäger AM, Paris S, Hsu LY, Tu YK. Treating pit-and-fissure caries: a systematic review and network meta-analysis. J Dent Res. 2015;94(4):522–33.
46. Cvikl B, Moritz A, Bekes K. Pit and fissure sealants-a comprehensive review. Dent J (Basel). 2018;6(2):18.
47. Gao J, Ruan J, Zhao L, Zhou H, Huang R, Tian J. Oral health status and oral health knowledge, attitudes and behavior among rural children in Shaanxi, western China: a cross-sectional survey. BMC Oral Health. 2014;14:144.
48. Cao C, Liao S, Cao W, Guo Y, Hong Z, Ren B, et al. Differences in the association of oral health knowledge, attitudes, and practices with frailty among community-dwelling older people in China. BMC Oral Health. 2023;23(1):782.
49. Bahammam S, Chen CY, Ishida Y, et al. Electric and manual oral hygiene routines affect plaque index score differently. Int J Environ Res Public Health. 2021;18(24):13123.
50. Nascimento AP, Watanabe E, Ito IY. Toothbrush contamination by Candida spp. and efficacy of mouthrinse spray for their disinfection. Mycopathologia. 2010;169(2):133–8.
51. Creeth JE, Gallagher A, Sowinski J, et al. The effect of brushing time and dentifrice on dental plaque removal in vivo. J Dent Hyg. 2009;83(3):111–6.
52. Liu W, Su L, Xie X, Xiang X, Huang J, Ji P. Association between toothbrushing and behavioral risk factors of non-communicable diseases: a population based survey of 4500 adults in China. Sci Rep. 2019;9(1):8498.
53. Sun HY, Jiang H, Du MQ, et al. The prevalence and associated factors of periodontal disease among 35 to 44-year-old Chinese adults in the 4th national oral health survey. Chin J Dent Res. 2018;21(4):241–7.
54. Wigen TI, Wang NJ. Characteristics of teenagers who use dental floss. Community Dent Health. 2021;38(1):10–4.
55. Murthy PS, Shaik N, Deshmukh S, Girish MS. Effectiveness of plaque control with novel pediatric oral hygiene need station (modified oral irrigation device) as compared with manual brushing and flossing: randomized controlled pilot trial. Contemp Clin Dent. 2018;9(2):170–3.
56. Radzki D, Wilhelm-Węglarz M, Pruska K, Kusiak A, Ordyniec-Kwaśnica I. A fresh look at mouthwashes-what is inside and what is it for? Int J Environ Res Public Health. 2022;19(7):3926.

Publisher's Note